QUINNIPIAC RIVER BASIN

MERIDEN/CHESHIRE, CONNECTICUT

BROAD BROOK DAM
CT. 00301

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

SEPTEMBER 1978

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ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

he Broad Brook Dam is a concrete dam that is 210 ft. long with a 70 ft. spillway t has a gate house with a 30 inch diameter blowoff and a 30 inch diameter water ain. Based on the visual inspection, records available at the site and past perational performance, the dam is judged to be in poor condition.

FORM

BROAD BROOK DAM
CT. 00301

QUINNIPIAC RIVER BASIN
MERRIDEN/CHESHIRE, CONNECTICUT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

SEP 29 1979

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

Inclosed is a copy of the Broad Brook Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, City of Meriden, Connecticut.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification Number:	CT 00301
Name:	Broad Brook Dam
Town:	Cheshire
County and State:	New Haven County, Connecticut
Stream:	Tributary to the Quinnipiac River
Date of Inspection:	July 25, 1978

BRIEF ASSESSMENT

The Broad Brook Dam is a concrete dam that is 210 feet long with a 70 foot spillway. It has a gate house with a 30 inch diameter blowoff and a 30 inch diameter water main.

Based on the visual inspection, records available at the site and past operational performance, the dam is judged to be in poor condition. A review of the limited engineering data available reveals that there are areas of concern that should be corrected or investigated further as to their effect on the integrity of the dam.

The east bank on the downstream side of the dam shows signs of fairly heavy seepage. This condition should be investigated further.

The project spillway will pass only 26 percent of the estimated Probable Maximum Flood (PMF), the recommended

spillway test flood. Therefore, further hydrologic and hydraulic studies are recommended to refine the spillway test flood, determine the ability of the dam to withstand overtopping, and if appropriate, measures for increasing spillway capacity.

Plans for around the clock surveillance should be developed for periods of unusually heavy rains and a formal warning system should be developed for use in the event of an emergency.

Recommended measures to be undertaken by the onwer include monitoring seepage, studying the overall conditon of the dam (cracks, erosion and areas of distress), studying vibration during high flows and establishing an inspection program. The owner should implement the recommendations and remedial measures described in Section 7 within one year after receipt of this Phase I Inspection Report.

Joseph F. Merluzzo
Connecticut P.E. #7639
Project Manager

Richard F. Lyon
Connecticut P.E. #8443
Project Engineer

This Phase I Inspection Report on Broad Brook Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Charles G. Tiersch

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Ravens Jr.

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface evaluations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify the need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and varity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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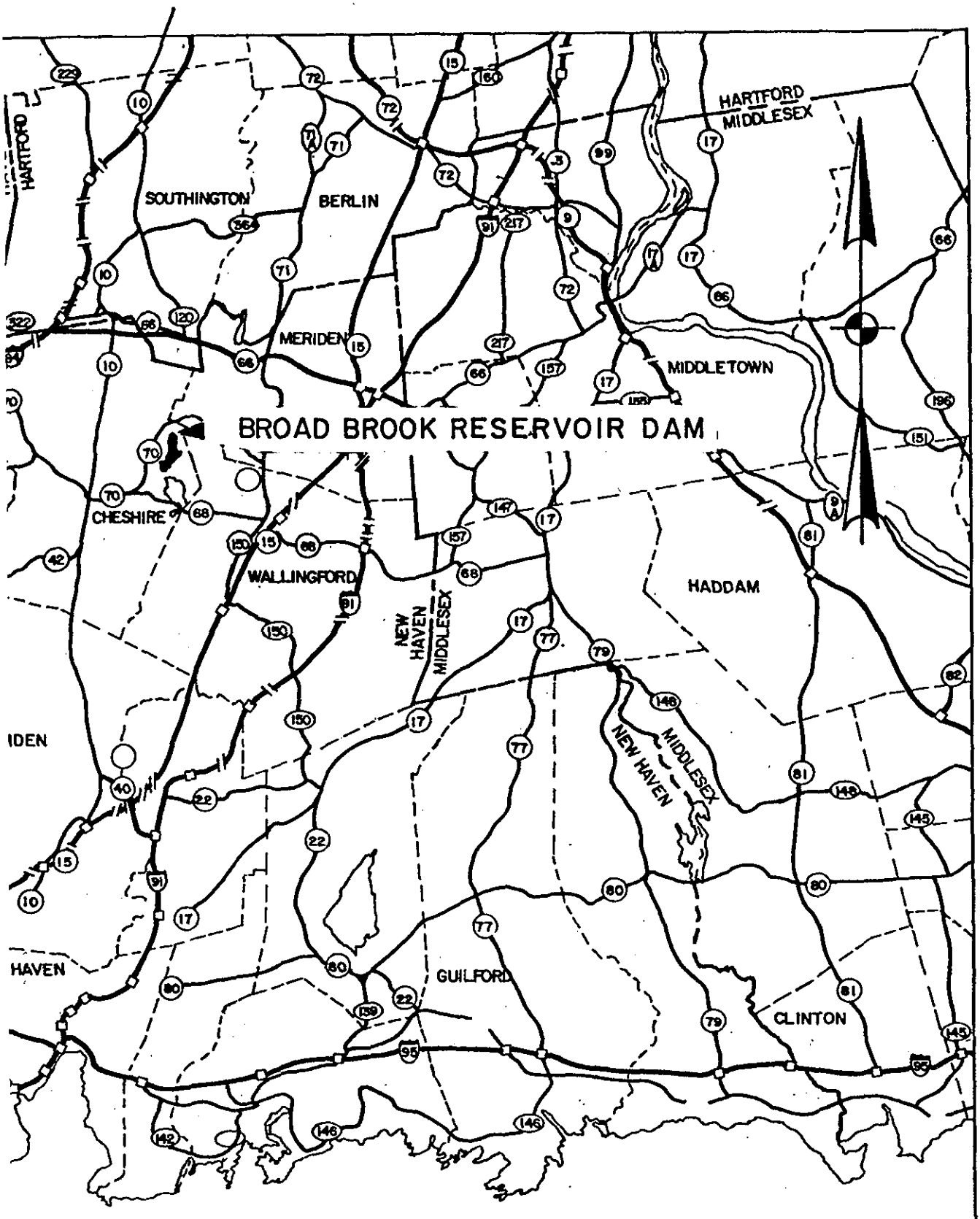


S. ARMY, CORPS OF ENGINEERS
NEW ENGLAND DIVISION
WALTHAM, MASS.

APPROXIMATE SCALE
SCALE OF MILES 0 10

LOCATION MAP

PHASE I INSPECTION REPORT

BROAD BROOK DAM

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority - Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Storch Engineers has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Storch Engineers under a letter of May 3, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0000 has been assigned by the Corps of Engineers for this work.

b. Purpose -

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and prepare the states to initiate quickly, effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

The Broad Brook Dam is one of 12 dams owned and operated by the Meriden Water Department, New Haven County, Connecticut.

It is located just outside of the City of Meriden right on the border of the Town of Cheshire (see Location Map) and is on Broad Brook, a part of the Quinnipiac River Basin.

The structure consists of a concrete dam that is approximately 210 feet long with the spillway length of approximately 70 feet. It has a gate house with a 30 inch diameter blowoff and a 30 inch diameter pipe to the newly constructed water treatment plant just downstream of the dam. The dam impounds the Broad Brook Reservoir which serves as a primary water supply for the City of Meriden.

The size classification of the dam is intermediate (50 feet high and 3,870 acre-feet of storage) and the hazard classification is high per the criteria set forth in the Recommended Guidelines for Safety Inspection of Dams by the Corps of Engineers. Immediately downstream is the Broad

Brook Water Filtration Plant which was recently reconstructed. Failure of this dam would result in severe damage to this facility and the loss of water for many water users in the City of Meriden.

The Broad Brook Dam was constructed in 1913 from designs prepared by the Meriden Water Department. There is a regular staff of maintenance personnel available at the water treatment plant but the maintenance performed on this dam is minimal. In 1927, the spillway was reconditioned and a drainage system for the body of the dam was installed (Appendix B, Plate 2). In 1976 and 1977 when the new plant was constructed, the sluice gate in the upper gate house was replaced.

The person in charge of day to day operation of the dam is Bruce Soroka, City Engineer, Meriden, Connecticut; Telephone Number: 634-0003.

1.3 Pertinent Data

a. Drainage Area - A 5.0 square mile drainage area contributes to the dam. The terrain is rolling with mixed amounts of farm land, orchards and residential development.

b. Discharge at Damsite - The maximum known spillway discharge was approximately 1,120 cfs during the flood of September, 1938.

(1) Outlet works: 30 inch conduit at invert elevation 85.0.

(2) Maximum known flood at damsite: 1,120 cfs.

(3) Ungated spillway capacity at maximum pool elevation: 1,450 cfs at 122.0 elevation.

(4) Gated spillway capacity at pool elevation N/A cfs at N/A elevation.

(5) Gated spillway capacity at maximum pool elevation N/A cfs at N/A elevation.

(6) Total spillway capacity at maximum pool elevation: 1,450 cfs at 122 elevation.

c. Elevation (Feet above MSL)

(1) Top of dam: 122.0

(2) Maximum pool-design surcharge: 122.0

(3) Full flood-control pool: N/A

(4) Recreation pool: N/A

(5) Spillway crest: 119.0

(6) Upstream portal invert diversion tunnel: 85.0

(7) Streambed at centerline of dam: 85.0

(8) Maximum tailwater (1938 Flood): 87.2

d. Reservoir

(1) Length of maximum pool: 12,000 feet ±

(2) Length of recreation pool: N/A

(3) Length of flood-control pool: N/A

e. Storage (Acre-Feet)

(1) Recreation pool: N/A

(2) Flood-control pool: N/A

(3) Design surcharge: 3,870 ±

(4) Top of dam: 3,870 ±

f. Reservoir Surface (Acres)

(1) Top dam: 422 ±

(2) Maximum pool: 422 ±

(3) Flood-control pool: N/A

(4) Recreation pool: N/A

(5) Spillway crest: 294 ±

g. Dam

(1) Type: Concrete - Gravity

(2) Length: 212 feet ±

(3) Height: 49 feet ±

(4) Top width: 8 feet ±

(5) Side Slopes: U/S - 1:0.05
D/S - 1:2 ±

(6) Zoning: N/A

(7) Imprevious Core: N/A

(8) Cutoff: 4 feet ±

(9) Grout curtain: unknown

(10) Other: N/A

h. Diversion and Regulating Tunnel (Conduit)

(1) Type: cast iron

(2) Length: 42 feet ±

(3) Closure: Not applicable

(4) Access: none

(5) Regulating facilities: Manually operated gate

i. Spillway

(1) Type: concrete - fixed weir

(2) Length of weir: 70 feet

(3) Crest elevation: 119.0 feet

(4) Gates: 12" flashboards (poor condition)

(5) U/S Channel: underwater

(6) D/S Channel: natural channel

(7) General: N/A

j. Regulating Outlets

Regulating outlets include a 30 inch blowoff that discharges just below the dam and a 30 inch water main that goes to the treatment plant several hundred feet downstream.

(1) Invert: 85.0

(2) Size: 30 inch

(3) Description: cast iron

(4) Control mechnism: manually operated gate valves

(5) Other: N/A

SECTION 2 - ENGINEERING DATA

2.1 Design

The available design information for this dam is in the form of contract drawings and two separate engineering studies. The first study was started by a private consultant and was not completed because of lack of funds. The second study was done by the Meriden Water Department to evaluate the effects of placing flashboards on top of the spillway.

In 1927, the face of the spillway was capped with 1.5 feet of concrete. An internal drainage system was installed at this time (Appendix B, Plate 2).

2.2 Construction

There are no records or photographs available for the construction of the original dam. The as-built information is contained on the contract plans, dated 1974, that were prepared for the gate house repair.

2.3 Operation

The operation of the sluice gates in the upper gate house structure is manual. In 1977, the 30 inch diameter sluice gate to the main plant as well as the valve for the blowoff line were repaired. The percentage of flow that can be released through these pipes is small and there is no

formal or written plan available for these valves to be opened during a storm. The spillway discharges about six months out of the year.

2.4 Evaluation

a. Availability - The construction drawings were readily available. Because of the age of the dam, there was no design information. The dam has no operating procedures.

b. Adequacy - The information that was made available was only a minor factor in the assessment, which was based mainly on the visual inspection, past performance history and hydrologic and hydraulic assumptions.

c. Validity - The construction drawings are accurate to the extent that the visible inspection did not reveal any new features.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General - The visual inspection was conducted on July 25, 1978 by members of the engineering staff of Storch Engineers, with the help of Mr. Donald Perry of the Meriden Water Department. A copy of the visual inspection check list is contained in the Appendix of this report.

The following procedures was used for the inspection:

1. The concrete face of the dam was surveyed for cracks, spalling, seepage and efflorescence.
2. The banks downstream of the dam were inspected for leakage or water loss.
3. The upstream face of the dam was checked for structural damage.
4. A visual check was made for bulges or movement in the existing embankment.
5. The temperature was taken of the upstream and downstream water as well as that of the seepage flow.
6. The dam and its appurtenant structures (Appendix C, Plate 4) were photographed.

Before the inspection commenced, the design and construction documents were studied and a compact sketch of the dam was prepared for use during the inspection (Appendix B, Plate 1).

In general, the overall condition of the dam and appurtenant structures is poor.

b. Dam - An inspection of the downstream face of the spillway revealed several areas which had spalled or showed signs of seepage. In one location on the west side of the spillway reinforcing bars were exposed. The concrete showed signs of distress to a depth of 2 to 4 inches, especially along the horizontal construction joints. The upstream face of the dam showed some signs of minor erosion and concrete spalling. A search for the four inch diameter outlet of the underdrain system that is shown on Plate 2, Appendix B, was not sucessful because of the considerable amount of silt deposited at the toe of the spillway. The wooden flashboards on the spillway were badly weathered and appeared useless.

On the east bank of the downstream side of the dam for a distance of about 200' $\pm$ there are wet spots that seem to flow at a fairly steady rate approximately 10 to 30 gallons/min. These wet areas are noticeable over the entire lower half of the slope and the approximate limits have been delineated on Plate 1, Appendix B. This bank has been completely overgrown with trees and underbrush.

c. Appurtenant Structures - The gate house has recently been repaired along with its gates, valves and operators during the recent treatment plant reconstruction. A conversation with the plumber, who made the modifications to the service gates, revealed that no major leaks into the gate house chamber were observed. The 30 inch diameter blowoff and water supply pipes are enclosed within the body of the dam. Although this gate house is somewhat unsightly, it appears structurally sound.

d. Reservoir Area - An inspection of the embankment adjacent to or just slightly upstream from the dam showed the area to be in a natural state. The alignment of the dam is good and there are no signs of movement of the upstream embankment.

e. Downstream Channel - The spillway and core of the main dam are both cut into ledge rock (Appendix B, Plate 2). The downstream side is faced with an earth embankment except for the spillway area. The downstream banks are so overgrown with trees and dense brush that it is difficult to determine any abnormalities. The silt at the toe of the dam causes the seepage water to lie stagnant during those times when the spillway is not flowing.

3.2 Evaluation

The visual inspection of this facility revealed some apparent areas of distress in the concrete. The observation of the extensive zone of seepage on the downstream slope of the dam indicates a need for further study so that the extent of this problem can be defined. Overall, the general condition of the dam is poor.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

The piping for this facility is operated only as required for the water treatment plant or if a drawdown of the reservoir is desired. There has been no formal procedure established for the lowering of the reservoir during periods of flooding. The maintenance staff that takes care of the Broad Brook Water Filtration Plant is also responsible for the maintenance of the dam.

4.2 Maintenance of the Dam

There is no routine maintenance procedure, however, there have been attempts to clear some of the undergrowth away from the face of the dam. Items such as clearing the downstream banks, repair of the internal drainage system and restoration of the concrete surface of the spillway does not appear to have been attempted recently.

4.3 Maintenance of Operating Facilities

The maintenance of the facilities which operate the dam consists of exercising the operators of the sluice gates and valves to the water main and blowoff and changing the screen in the well of the gate house.

During the reconstruction of the water treatment plant in 1976 and 1977, the stems in the gate house which operate the valves and sluice gates for the 30 inch main and blowoff were repaired. The frequency of operation prior to this repair had been minimal.

4.4 Description of Warning System

There is no warning system in effect.

4.5 Evaluation

In view of the lack of routine maintenance procedures, it is suggested that written procedures be established. There has been no recent effort made to clean-up the downstream area or to repair damage to the body of the dam itself.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data - The 70 foot spillway, 30 inch blowoff and 30 inch water main are the only means of transmitting water past the dam. Under conditions of the Probable Maximum Flood (PMF), the spillway will carry only a portion of the flood water.

Using the guide curves supplied by the Corps of Engineers (rolling terrain), the PMF inflow into the reservoir is 9,250 cfs and the routed outflow is 5,500 cfs. The pond elevation at the PMF is 124.5 or 2.5 feet over the top of the dam. The Spillway Design Flood (SDF) is only 1,450 cfs, approximately 26 percent of the PMF (Appendix D).

b. Experience Data - The Broad Brook Reservoir Dam has experienced the floods of November, 1927; March, 1936; September, 1938 (maximum) and August and October, 1955. During the flood of September 1938, the elevation of the pond was 121.75 feet and the discharge was approximately 1,120 cfs.

c. Visual Observations - The spillway at the time of the inspection was in poor condition with some evidence of water seeping through its construction joints (Appendix C, Photo 5).

The river channel downstream is overgrown with trees and brush and is not conducive to the free passage of flood flows. This condition is found from the dam to the confluence of Broad Brook with the Quinnipiac River.

The 30 inch blowoff and the 30 inch water main are in good condition.

d. Overtopping Potential - Calculations by Storch Engineers indicates that the PMF will overtop the dam by 4.2 feet. However, since the dam is constructed of concrete, it may withstand some overtopping. One half of the PMF would result in about one foot of overtopping.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations - There are no routine inspections performed by the staff of the Meriden Water Department, however, maintenance personnel from the treatment plant operate the sluice gate of the water supply main as necessary. The results of the visual inspection showed that the structure is stable, however, the deep concrete damages and extensive seepage on the east bank could cause problems during normal operation.

b. Design and Construction Data - The only design and construction data available were two original contract drawings of September, 1929 and the oral information of the resident staff.

c. Operating Records - There are no operating records. The water level of the Broad Brook Reservoir is not monitored.

d. Post Construction Changes - The following changes to the Broad Brook Reservoir Dam facility have been noted since the completion of construction in 1913:

1. Considerable damage to the concrete face of the dam, especially along the horizontal construction joints of the downstream slope of the spillway.

There are erosion areas which are four inches deep with rusted reinforcement that is exposed (Appendix C, Photo 7).

2. The replacement of the deteriorated portions of the downstream concrete spillway slope in conjunction with the installation of a suface drainage system in September, 1929.

e. Seismic Stability - The dam is located in Seismic Zone No. 1 and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition - After carefull review of the available documents, the results of this inspection and the meetings with the resident staff, the conclusion is that the general condition of the Broad Brook Reservoir Dam is poor. Although there are no signs that the dam has insufficient structural stability, there are several evidences of damaged concrete, obstruction of the internal drainage system and intensive seepage areas on the east side of the downstream bank. Each of these deficiencies could lead to a dangerous condition in the future.

b. Adequacy of Information - The information available is such that the assessment of the safety of the dam should be based primarily on the visual inspection results and the past operational performance of the structures.

c. Urgency - The onwer shall implement the recommendations within one year after receipt of this Phase I Inspection Report.

d. Need for Additional Investigation - Additional observations and investigations of the dam by a qualified engineering firm should be initiated especially in the areas of seepage, underground water pressure and concrete properties.

7.2 Recommendations

In view of the concern for the safety of the dam and the lack of the engineering data for the evaluation of its condition, it is recommended that the following measures be undertaken by the owner:

1. Instrumentation should be provided to monitor the dam behavior. This instrumentation should include the metering of upstream and downstream water levels, daily; seepage discharges in all springs on the east downstream bank and in other discovered springs including the body of the dam, monthly; and seepage pressure at the base of the dam by the installation of the piezometers, monthly.
2. Temperature of seepage water and reservoir water below the water surface at depths of 1 foot, 10 feet and 30 feet, monthly and simultaneously with the measurement of seepage discharges;
3. Chemical analyses of the reservoir and the seepage water in the all the springs, yearly and simultaneously with the measurement of discharge. The water should be checked for pH, hardness, Ca, Mg, CO_3, HCO_3, Na+K and CO_2.

4. Sketches and photographs of the damaged surfaces (caverns, erosion areas, cracks, rust reinforcement and spalling) of the top, upstream (with reservoir level lowered) and downstream slopes of the dam and the concrete walls of the gate house, yearly. There should also be a measurement of the depth and area of these distresses and the width of cracks.
5. The vibration of the body of the dam during the passage of high flows across the spillway.
6. Determination of the exact geometrical size of the dam, the elevation of its base, the primary properties of the concrete and concrete masonry for assessment of structural stability.
7. A watershed study should be done so that the characteristics of the reservoir can be determined.
8. A systematic inspection program (once every two years) during periods of the highest and lowest reservoir water levels should be developed to assure that all features of the dam are continually maintained.

Any of the above recommendations that require additional investigation should be done by a qualified engineering firm.

7.3 Remedial Measures

It is considered important that the following items be attended to within one year:

a. Alternatives - Not applicable.

b. O & M Maintenance and Procedures -

(1) The grass, brush and trees on the downstream slopes of the dam and banks at the distance of 300 feet from the dam should be removed to facilitate the visual observation of existing and potential seepage.

(2) Restoration of the existing drainage system in the body of the dam.

(3) The repair of the concrete faces of the dam with the removal of weak and deteriorated concrete.

(4) The downstream channel of the spillway should be cleaned of rock deposits, brush and trees so that overflow discharges from the spillway and the blowoff can be passed freely.

(5) A formal warning system should be developed including an operational procedure to follow in the event of an emergency.

(6) The flashboards that are on top of the spillway should either be repaired or removed.

APPENDIX A

VISUAL INSPECTION CHECK LIST A-1 to A-6

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Broad Brook Reservoir Dam DATE 7-25-78

TIME

WEATHER Sunny

W.S. ELEV. 118.75 U.S. 87.5 DN.S.

PARTY:

1. Richard Lyon
2. Miron Petrovsky
3. Gary Giroux
4. John Schearer
5. Don Perry (Meriden Water Dept.)
6.
7.
8.
9.
10.

PROJECT FEATURE	INSPECTED BY	REMARKS
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Temperature of Air 80° F

Temperature of Water 80° F (upstream)

Temperature of Seepage 62° F

PERIODIC INSPECTION CHECK LIST

PROJECT Broad Brook Reservoir Dam DATE 7-25-78

PROJECT FEATURE _____ NAME R. Lyon

DISCIPLINE _____ NAME G. Giroux

AREA EVALUATED	CONDITIONS
DAM ~~EMBANKMENT~~	
Crest Elevation	Fair
Current Pool Elevation	Fair
Maximum Impoundment to Date	Fair
Surface Cracks	Minor hairline cracks noted
Pavement Condition	N/A
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Fair to good
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on ~~Slopes~~ Dam	Not permitted (not patrolled)
Sloughing or Erosion of Slopes or Abutments	Some observed on face of concrete
Rock Slope Protection - Riprap Failures	N/A
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	East bank shoed considerable leakage
Piping or Boils	None
Foundation Drainage Features	N/A
Toe Drains	None
Instrumentation	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT Broad Brook Reservoir Dam DATE 7-25-78

PROJECT FEATURE _____ NAME M. Petrosvky

DISCIPLINE _____ NAME J. Schearer

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	
Bottom Conditions	Underwater
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	Underwater
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Broad Brook Reservoir Dam DATE 7-25-78

PROJECT FEATURE _____ NAME G. Giroux

DISCIPLINE _____ NAME M. Petrovsky

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Fair to good
Condition of Joints	Good
Spalling	None
Visible Reinforcing	None
Rusting or Staining of Concrete	None
Any Seepage or Efflorescence	Underwater
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	None (according to Contractor on job)
Cracks	N/A
Rusting or Corrosion of Steel	N/A
b. Mechanical and Electrical	
Air Vents	N/A
Float Wells	N/A
Crane Hoist	N/A
Elevator	N/A
Hydraulic System	N/A
Service Gates Emergency Gates	Good condition (recently repaired)
Lightning Protection System	N/A
Emergency Power System	N/A
Wiring and Lighting System in [illegible]	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT Broad Brook Reservoir Dam DATE 7-25-78

PROJECT FEATURE _____ NAME R. Lyon

DISCIPLINE _____ NAME J. Schearer

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Encased in the body of the dam.
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT Broad Brook Reservoir Dam DATE 7-25-78

PROJECT FEATURE _____ NAME M. Petrovsky

DISCIPLINE _____ NAME G. Giroux

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Underwater
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None
Spalling	Considerable amount on face of spillway
Any Visible Reinforcing	Some observed on west side of spillway
Any Seepage or Efflorescence	Many evidences at joints seen
Drain Holes	Drain hole could not be located
c. Discharge Channel	
General Condition	Fair
Loose Rock Overhanging Channel	N/A
Trees Overhanging Channel	Heavily overgrown
Floor of Channel	Silt and loose material evident
Other Obstructions	None

APPENDIX B

References Nos. 1 and 2 are located at the Engineering Department, City of Meriden, Connecticut.

1. "Engineering Data of Dams of Meriden Water Department"; City Engineers' Office; Meriden, Connecticut.

2. "Plan, Elevation and Spillway Section of Broad Brook Dam, Contract Drawings; September 20, 1926; City Engineers' Office; Meriden, Connecticut.

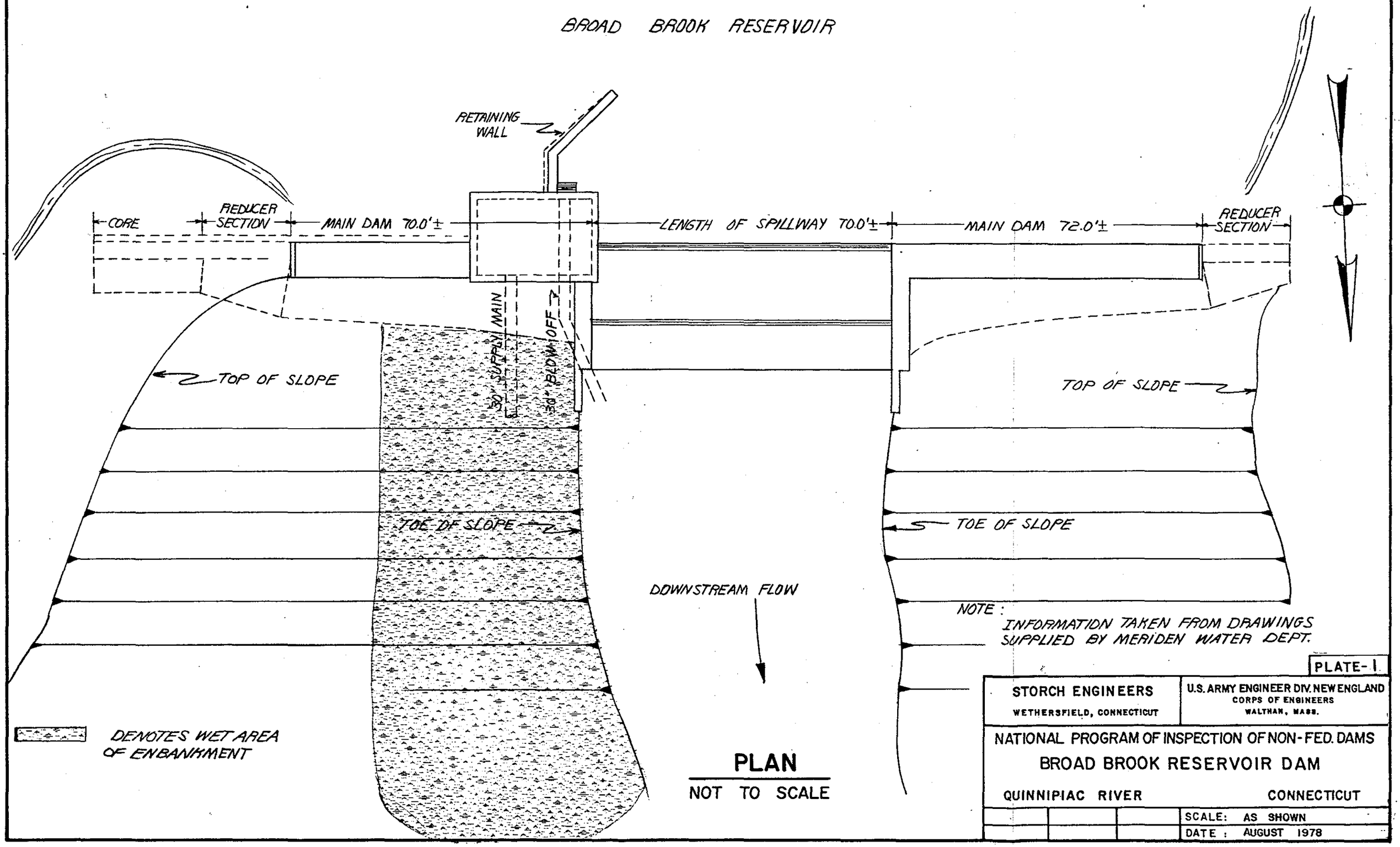
3. Recommended Guidelines for Safety Inspection of Dams. Department of the Army; Office of the Chief of Engineers; Washington, D.C.; November, 1976.

4. Guide Curves for the Probable Maximum Flood (PMF) for Regions of New England based on past Corps of Engineers' March, 1978.

5. Preliminary Guidance for Estimating Maximum Probable Discharges in Phase I Dam Safety Investigations; New England Division; Corps of Engineers; March, 1978.

6. Rule of Thumb. Guidance for Estimating Downstream Dam Failure Hydrographs; Corps of Engineers; April, 1978.

BROAD BROOK RESERVOIR



PLAN

NOT TO SCALE

NOTE :
INFORMATION TAKEN FROM DRAWINGS SUPPLIED BY MERIDEN WATER DEPT.

PLATE-1

STORCH ENGINEERS WETHERSFIELD, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

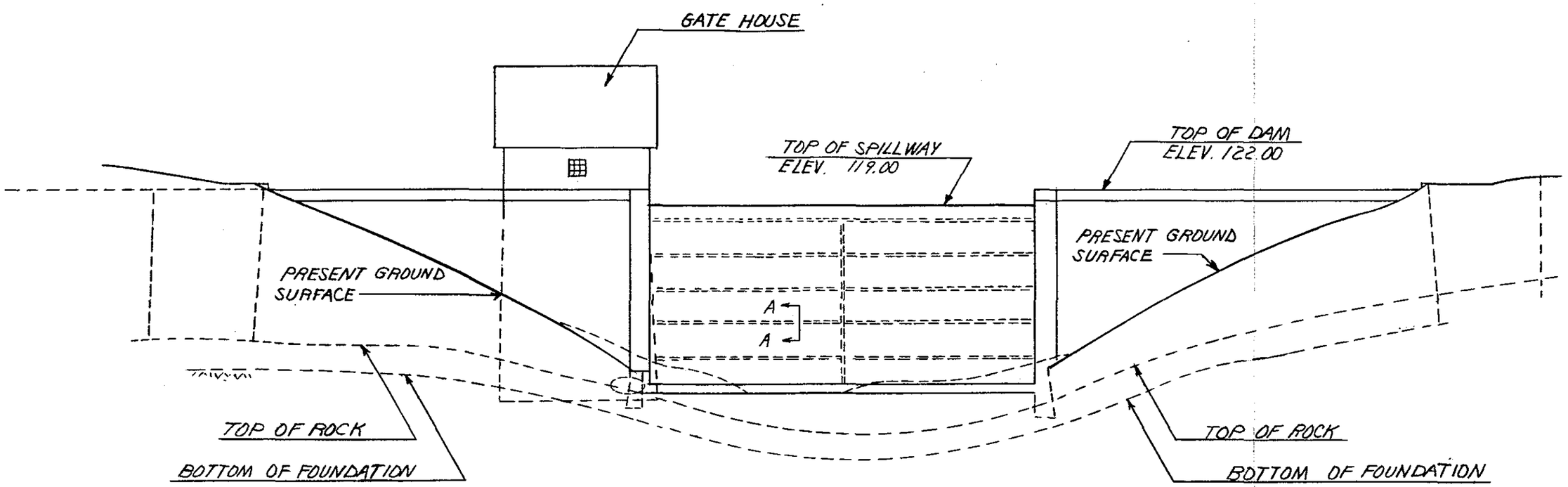
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BROAD BROOK RESERVOIR DAM

QUINNIPIAC RIVER — CONNECTICUT

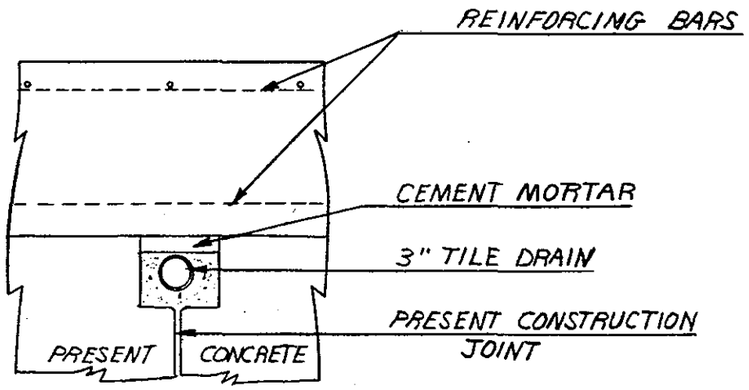
SCALE: AS SHOWN

DATE : AUGUST 1978



ELEVATION

NOT TO SCALE



SECTION A-A

NOTE :
INFORMATION TAKEN FROM DRAWINGS
SUPPLIED BY MERIDEN WATER DEPT.

PLATE-2

STORCH ENGINEERS WETHERSFIELD, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

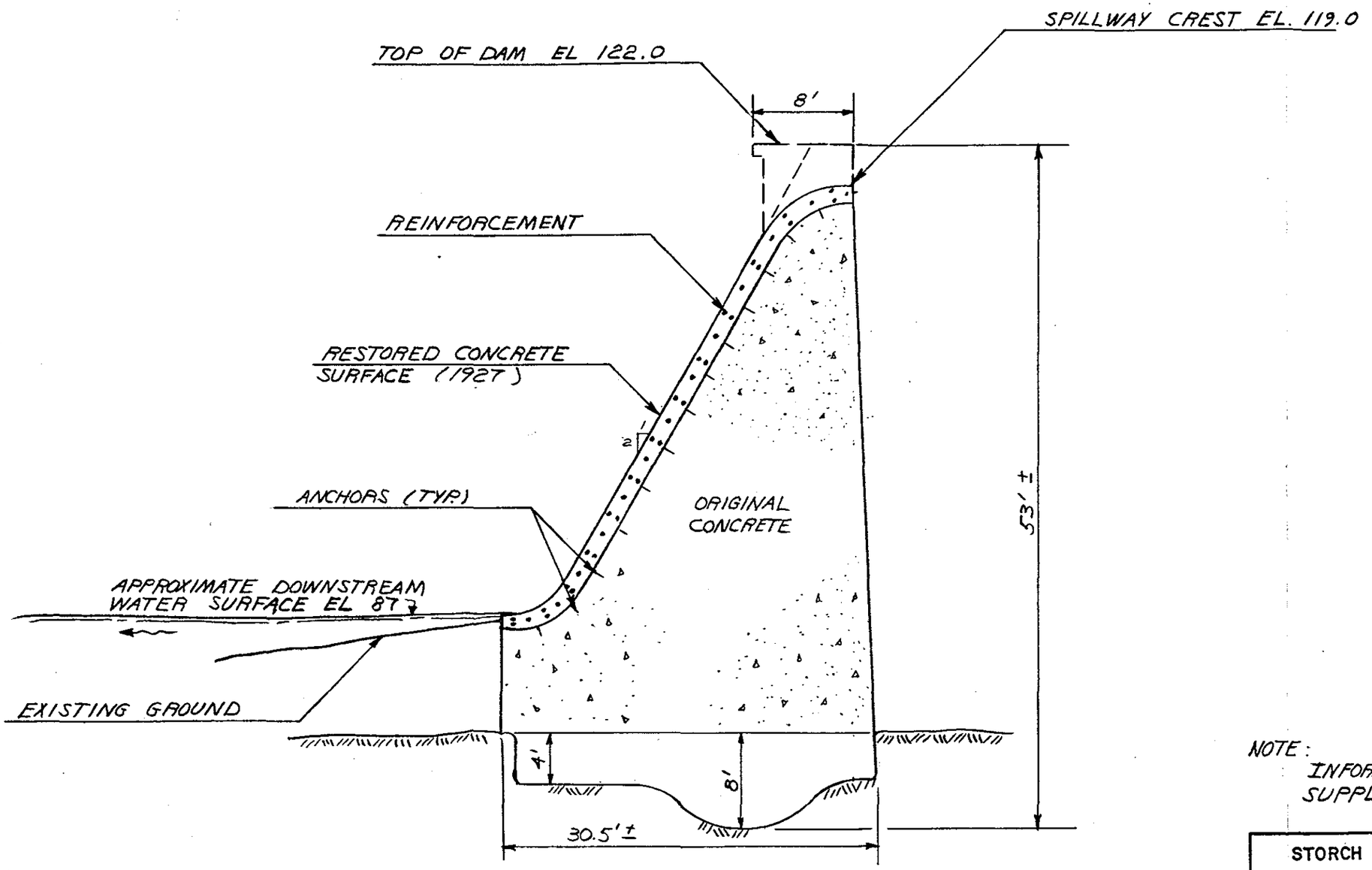
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BROAD BROOK RESERVOIR DAM

QUINNIPIAC RIVER CONNECTICUT

SCALE: AS SHOWN

DATE : AUGUST 1978



SPILLWAY SECTION

NOT TO SCALE

NOTE:
INFORMATION TAKEN FROM DRAWINGS SUPPLIED BY MERIDEN WATER DEPT.

PLATE-3

STORCH ENGINEERS WETHERSFIELD, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BROAD BROOK RESERVOIR DAM

QUINNIPIAC RIVER — CONNECTICUT

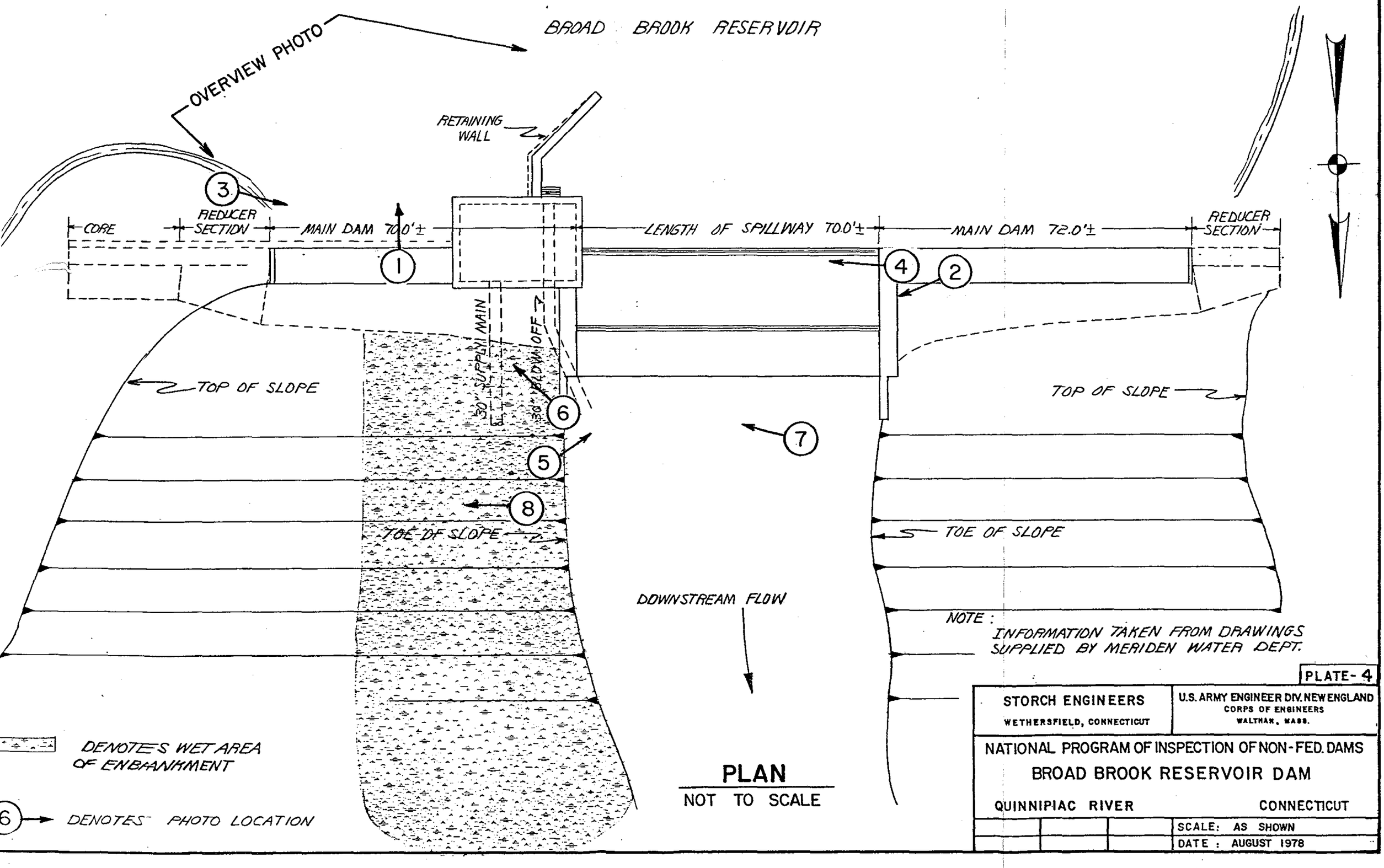
SCALE: AS SHOWN

DATE : AUGUST 1978

APPENDIX C

PHOTO LOCATION PLAN	Plate 4
PHOTOGRAPHS	II-1 to II-4

BROAD BROOK RESERVOIR



PLAN
NOT TO SCALE

NOTE :
INFORMATION TAKEN FROM DRAWINGS SUPPLIED BY MERIDEN WATER DEPT.

PLATE- 4

STORCH ENGINEERS WETHERSFIELD, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BROAD BROOK RESERVOIR DAM

QUINNIPIAC RIVER — CONNECTICUT

SCALE: AS SHOWN

DATE : AUGUST 1978

PHOTO 1

UPSTREAM RESERVOIR AREA

PHOTO 2

DOWNSTREAM CHANNEL AREA

PHOTO 3
DAMAGE TO UPSTREAM FACE OF DAM

PHOTO 4
FLASHBOARDS ON CREST OF SPILLWAY

PHOTO 5

DOWNSTREAM FACE OF SPILLWAY

PHOTO 6

SEEPAGE FROM FACE OF DAM

PHOTO 7

DAMAGE TO EAST FACE OF SPILLWAY AND MAIN DAM

PHOTO 8

SEEPAGE FROM EAST BANK OF DOWNSTREAM CHANNEL

APPENDIX D

BROAD BROOK RESERVOIR DAM
STAGE DISCHARGE

SEE PLATES & FOR PLAN & ELEVATION

SPILLWAY $Q = CLH^{3/2}$ DAM $Q = CLH^{3/2}$

	L=70'			L=116.5'	
H	C	Q	ELEV.	H	C	Q
0.0	-	0.0	119.0			
1.0	3.41	240	120.0			
1.5	3.55	457	120.5			
2.0	3.71	735	121.0			
2.5	3.82	1055	121.5			
3.0	3.9	1420	122.0	0.0	-	0.0
3.5	4.02	1840	122.5	0.5	2.70	110
4.0	4.09	2290	123.0	1.0	2.68	310
4.5	4.21	2815	123.5	1.5	2.65	570
5.0	4.29	3360	124.0	2.0	2.64	870
5.5	4.33	3910	124.5	2.5	2.64	1215
6.0	4.39	4520	125.0	3.0	2.64	1600

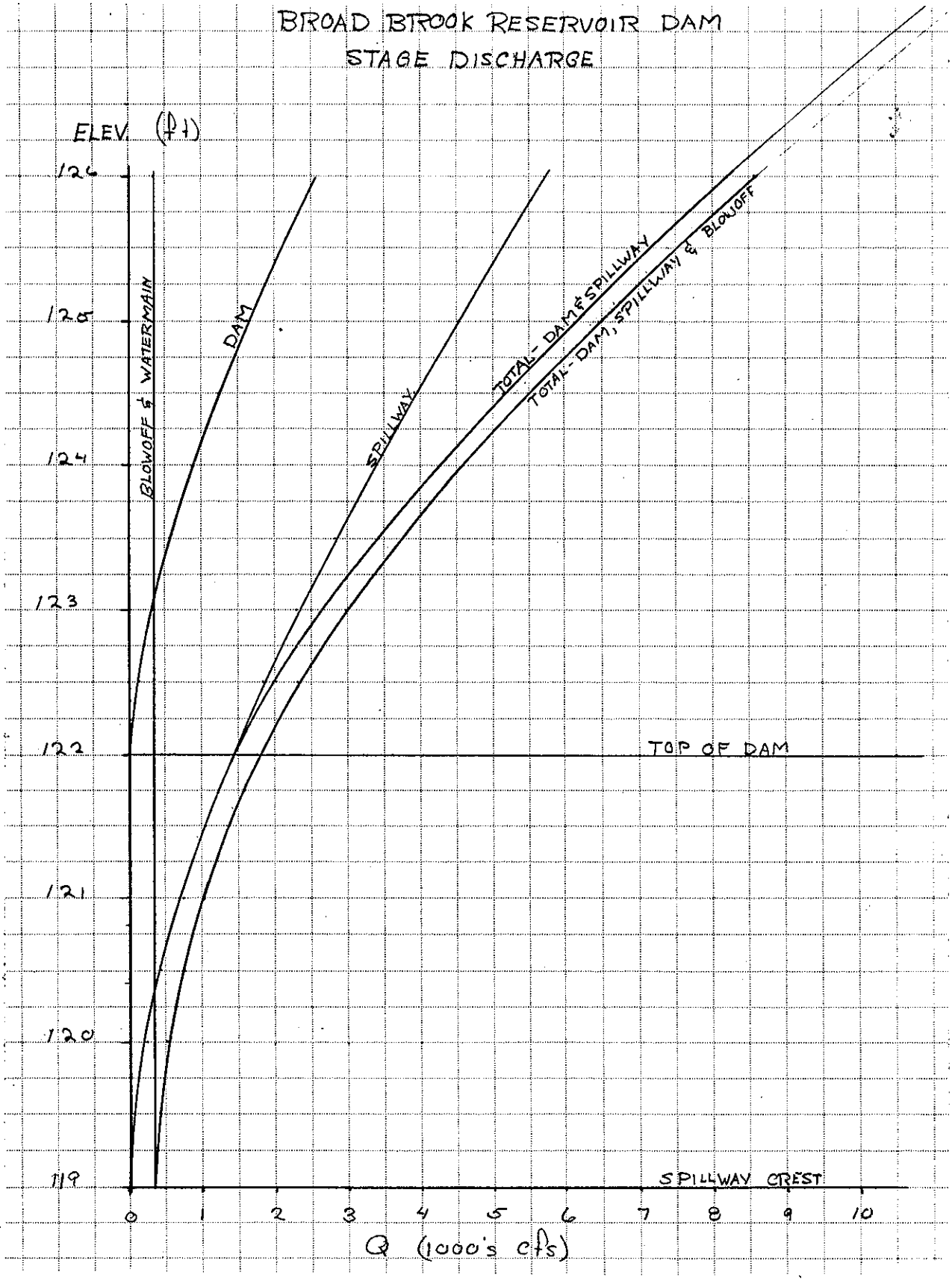
Flow through water main & blowoff
Say h = 34' (pond elevation @ spillway crest)

$Q = CA\sqrt{2gh}$

$Q_{blowoff} = .83(4.9)\sqrt{2(32.2)(34)'} = 190$ cfs

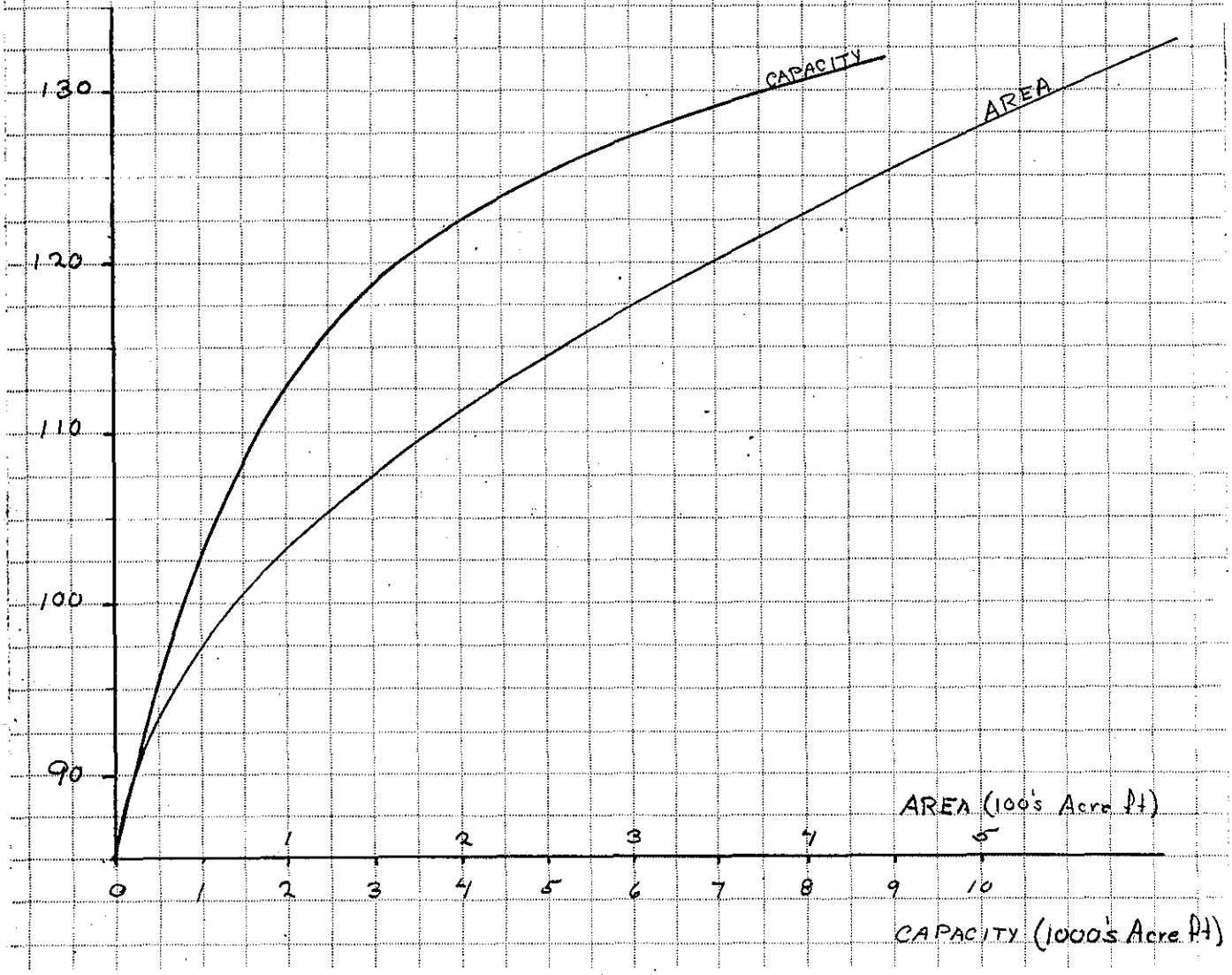
$Q_{water\ m.} = .5\ (4.9)\sqrt{2(32.2)(34)'} = 115$ cfs

Total 305 cfs


BROAD BROOK RESERVOIR DAM
STAGE DISCHARGE
ELEV (ft)
126
125
124
123
122
121
120
119
BLOWOFF & WATERMAIN
DAM
SPILLWAY
TOTAL - DAM & SPILLWAY
TOTAL - DAM, SPILLWAY & BLOWOFF
TOP OF DAM
SPILLWAY CREST
0
1
2
3
4
5
6
7
8
9
10
Q (1000's cfs)

BROAD BROOK RESERVOIR DAM
AREA - CAPACITY CURVE

ELEV	DEPTH	AREA	AVG AREA	VOL.	ΣVOL (Acre Ft)
85				1.009 BG	0
	34			3097 AcFt	
119		294			3097
	3		358	774	
122		422			3870
	10		505	5050	
132		588			8920



BROAD BROOK RESERVOIR DAM
DETERMINATION OF SDF & PMF

Drainage Area - 5.0 SM

Inflow (Ref) - 1850 cfs/SM

PMF = 5 × 1850 = 9250 cfs

Determine the effect of surcharge storage on Maximum Probable Discharge (Ref)

① Q_{P1} = 9250 cfs

② a. H_1 = 126.5' (Elev)

b. $STOR_1$ = 9.375"

c. $Q_{P2} = Q_{P1}(1 - STOR/19) = 9250(1 - 9.375/19) = 4685$ cfs

③ a. H_2 = 124.25' (Elev)

$STOR_2$ = 6.0"

b. $STOR_{AVG}$ = 7.69"

$Q_{P3} = 9250\left(1 - {}^{7.69}/_{19}\right) = 5500$ cfs

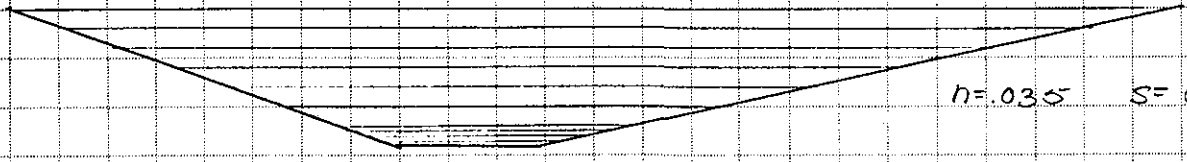
H_3 = 126.2' (Elev)

PMF = 5500 cfs

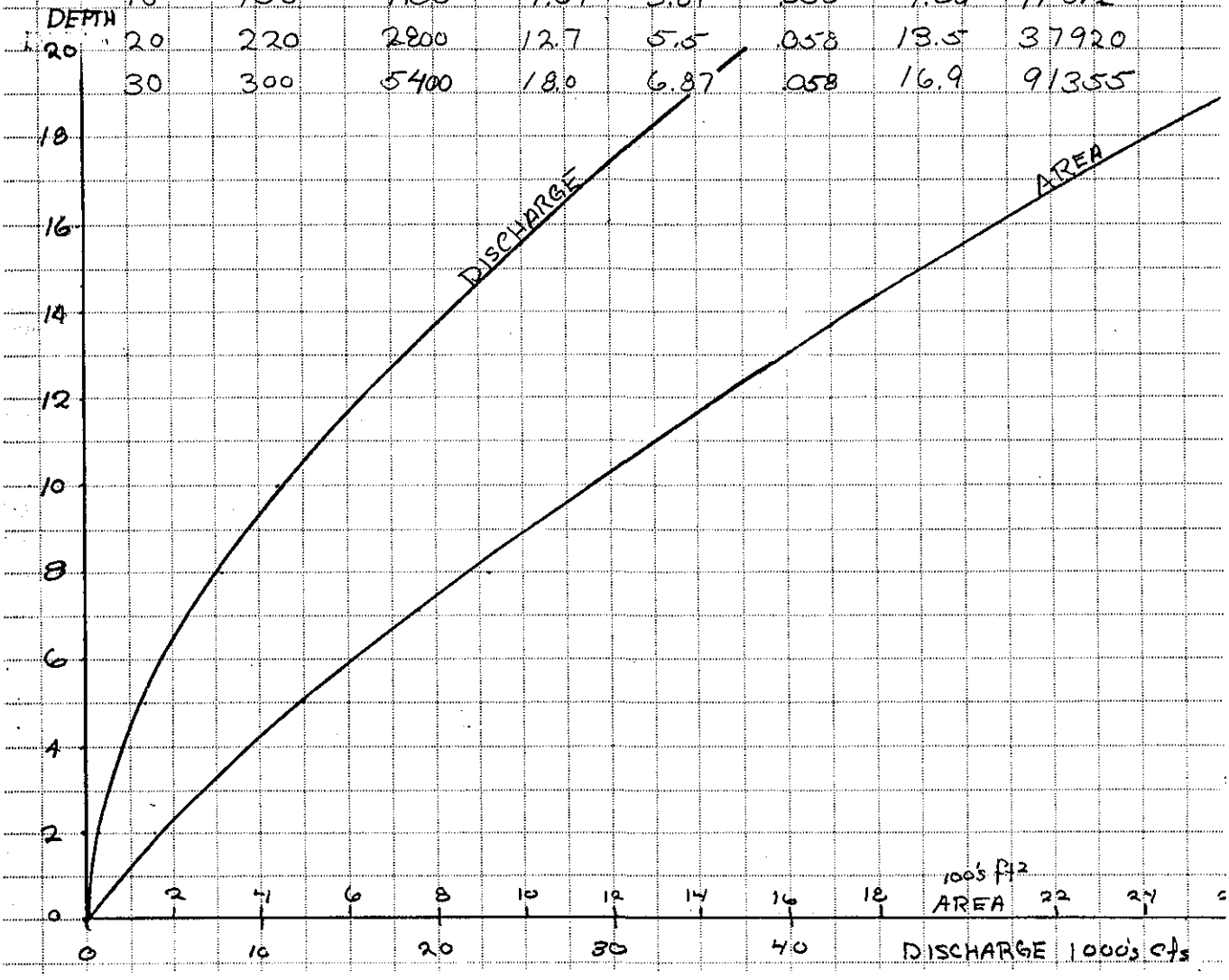
Capacity of Spillway when the pond elevation is @ top of the dam

Q = 1450 cfs or 26 % of PMF

BROAD BROOK RESERVOIR DAM
SECTION NO. 1 Quinipiac Gorge



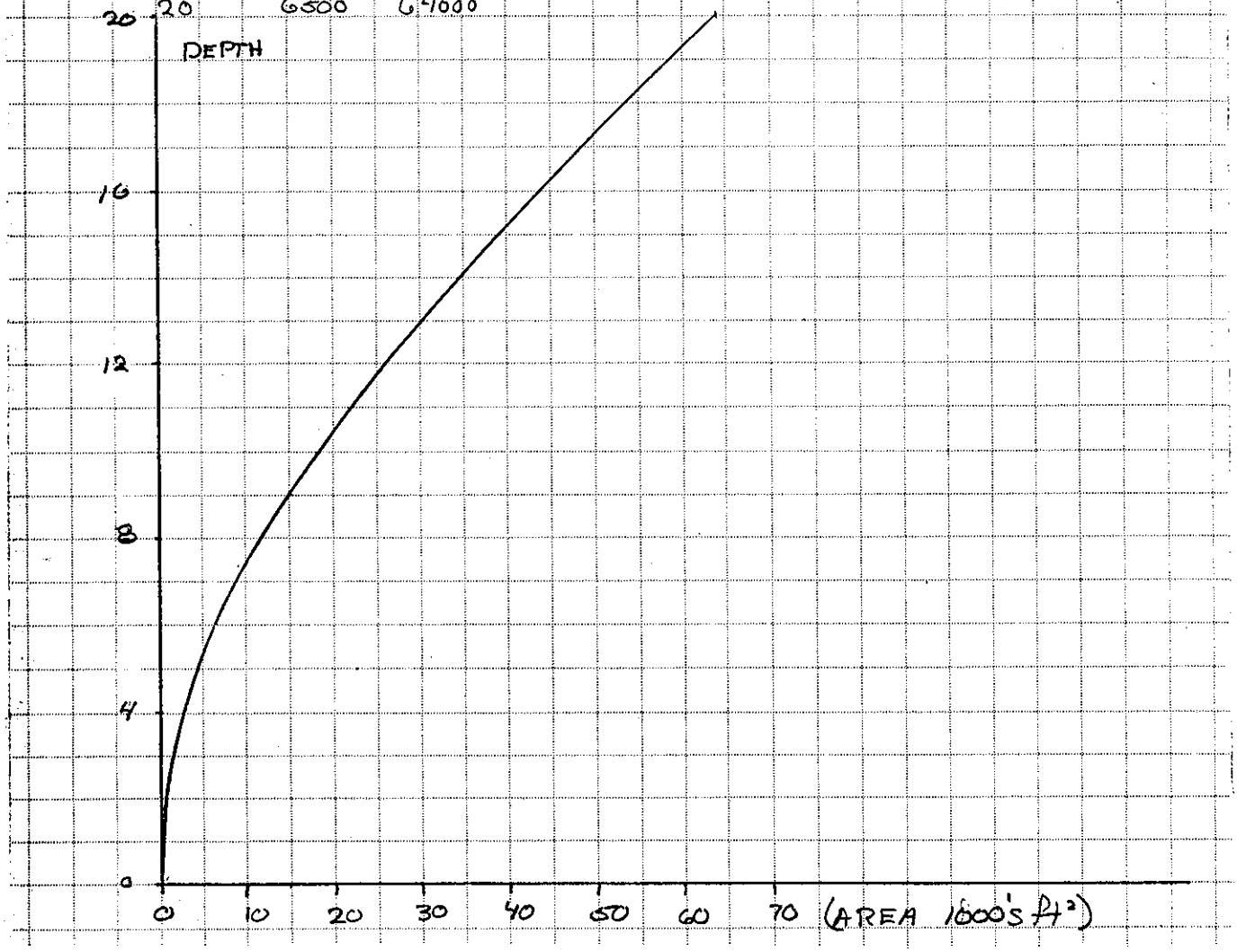
D	W	A	R	$R^{2/3}$	$S^{1/2}$	V	Q
2	82	160	1.95	1.56	.058	3.84	615
5	110	500	4.5	2.74	.058	6.74	3370
8	140	920	6.57	3.51	.058	8.64	7950
10	150	1150	7.67	3.89	.058	9.58	11012
20	220	2800	12.7	5.5	.058	13.5	37920
30	300	5400	18.0	6.87	.058	16.9	91355



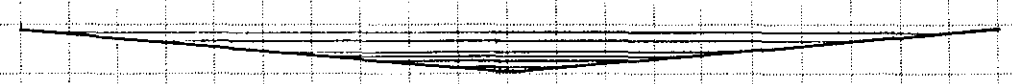
BROAD BROOK RESERVOIR DAM
SECTION NO. 2 U/S QUINIPIAC RIVER

BACKWATER STORAGE ONLY

D	WP	A
5	1800	4500
10	3200	18000
20	6500	64000



BROAD BROOK RESERVOIR DAM
SECTION NO 3 D/S QUINIPIAC RIVER



n = .035 S = .08%

SCALE
1" = 10'
1" = 400'

D	W	A	R	$R^{2/3}$	$S^{1/2}$	V	Q
2	200	200	1	1	.028	1.19	240
5	500	1250	2.5	1.84	.028	2.19	2750
8	750	3600	4.8	2.85	.028	3.39	12,200
10	900	5000	5.6	3.14	.028	3.73	18,660
15	1420	12000	8.45	4.15	.028	4.93	59,200
20	1800	19000	10.6	4.8	.028	5.7	108,420

"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURU HYDROGRAPHS

SECTION I @ DAM

① S = 3870 Ac-ft

② $Q_{P1} = 8/27\ W_b \sqrt{g}\ Y^{3/2} = 8/27\ (48)\sqrt{32.2}\ (37)^{3/2} = 18160$ cfs

SECTION II @ Quinnipiac Gorge

③ See Rating Curve No 1

④ a. $H_1 = 13'$ $A_1 = 1600$ ft² $L = 7,500$ "

$V_1 = 275$ Ac-ft

2400' of backwater u/s $V = 1650$ Ac-ft (Section No 2)

$V_{11} = 1925$ Ac-ft

b. $Q_{P2} = 18160\ (1 - 1925/3870) = 9130$ cfs

c. $H_2 = 9'$ $A_2 = 1,000$ ft²

$A_{avg} = 1,300$ ft² $V_2 = 1050$ Ac-ft

$Q_{P2} = 18160\ (1 - 1050/3870) = 13,232$ cfs

$H_2 = 11'$ $A_2 = 1300$ ft²

SECTION III @ Hanover Pond (Rating Curve No 3)

④ a. $H_2 = 11.0'$ $A_2 = 3300$ ft² $L = 1000'$

$V_2 = 80$ Ac-ft

b. $Q_P = 13230\ (1 - 80/3870) = 13130$ cfs

c. $H_3 = 8.25'$ $A_3 = 3700$ ft²

$A_{avg} = 2500$ ft² $V_{avg} = 57$ Ac-ft

$Q_{P3} = 13280\ (1 - 57/3870) = 13,000$ cfs

$H_3 = 8.2'$ $A_3 = 3650$ ft²

SECTION IV @ Rte 6 & Yalesville (Rating Curve No 3)

④ a. $H_3 = 8.2'$ $A_3 = 3650$ ft² $L = 16000'$

$V_3 = 1340$ Ac-ft

b. $Q_{P4} = 13000\ (1 - 1340/3870) = 8500$ cfs

c. $H_4 = 6.75'$ $A_4 = 1600$ ft²

$A_{avg} = 2625$ ft² $V_{avg} = 964$ Ac-ft

$Q_{P4} = 13000\ (1 - 964/3870) = 9760$ cfs

$H_{11} = 7.75'$ $A_{11} = 3000$ ft²

SECTION I @ Toelles Rd. Quinnipiac (Rating Curve No 3)

④ a. $H_4 = 7.25'$ $A_4 = 3000'^2$ $L = 26000'$

$V_4 = 1790$ Ac-ft

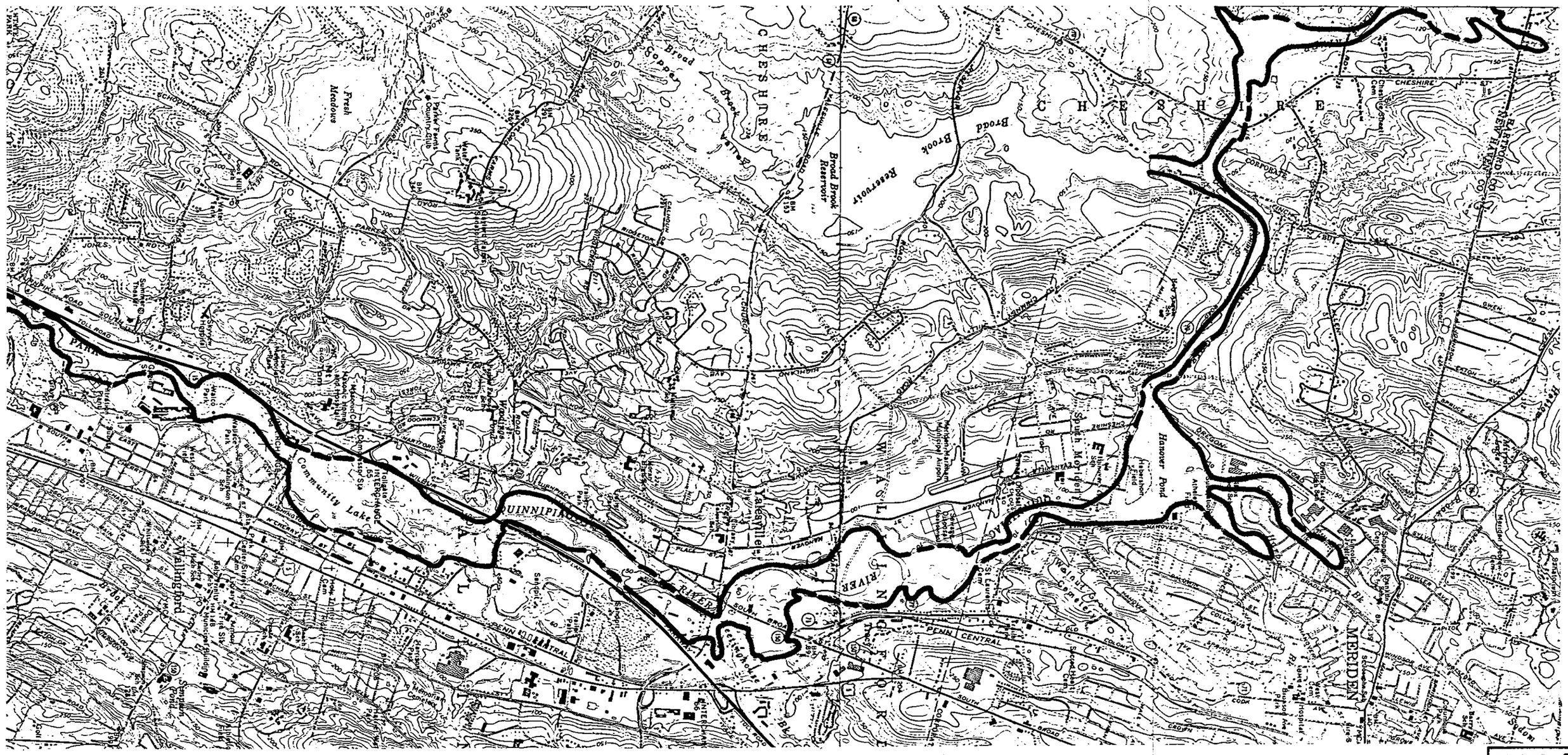
b. $Q_{P5} = 9760\,(1 - 1790/3870) = 5250$ cfs

c. $H_5 = 5.75'$ $A_5 = 1800$ ft^2

$A_{avg} = 2400$ ft^2 $V_{avg} = 1430$ Ac-ft.

$Q_{P5} = 9760\,(1 - 1430/3870) = 6150$ cfs

$H_5 = 6.1'$ A



REGIONAL VICINITY MAP

PLATE-5

LEGEND

DENOTES LIMITS OF FLOODING IN CASE OF DAM FAILURE

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

DATUM IS MEAN SEA LEVEL

STORCH ENGINEERS WETHERSFIELD, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

BROAD BROOK RESERVOIR DAM

QUINNIPIAC RIVER CONNECTICUT

SCALE: AS SHOWN

DATE : AUGUST 1978

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY	MO	YR
CT	301	NED	CT	009	05				BROAD BROOK RESERVOIR DAM	4131.4	7251.5	18	AUG	78

POPULAR NAME	NAME OF IMPOUNDMENT
	BROAD BROOK RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	07	TR-QUINNIPIAC RIVER	SOUTH MERIDEN	2	10000

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
CTPG	1913	S	53	35	3850	3100	NED	N	N	N	N	17AUG78

REMARKS

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	212	C	70	1450	7150											

OWNER	ENGINEERING BY	CONSTRUCTION BY
CITY OF MERIDEN CT	CITY OF MERIDEN CT	

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION
STORCH ENGINEERS	25	JUL	78	PL92-367

REMARKS